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Teachers implementing new primary school digital technology areas: What are we teaching now?

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Abstract

New digital technology areas were added to the New Zealand primary school technology curriculum in 2020. These areas aim to grow students who are not just passive users of technology but, instead, students who understand how computers work, who are digital creators, informed by design processes and critical thinking. The new digital areas of the technology curriculum appear to have created tension between the expectations of teachers and their relative capabilities. Examining three primary teachers' implementation of the new digital areas, this project utilised a participatory action research (PAR) methodology to review teachers' journey of adoption. Findings indicated that implementing the curriculum areas was not as complex as teachers first imagined and that unplugged activities (those without devices) played a significant role in the new digital technology areas' successful implementation in the classroom. The main themes that appeared from the data included levels of teacher knowledge, teacher confidence and curriculum learning area integration.

Keywords

Digital technology; unplugged; computational thinking; designing and developing digital outcomes

Introduction

New digital technology areas in the primary school curriculum (DTC) were first introduced in 2017 and became a mandatory part of the primary New Zealand Curriculum (NZC) technology subject area in 2020. DTC aims to develop students who are not just passive users of technology, but rather students who understand how computers work and are digital creators, informed by design processes and critical thinking (Ministry of Education [MoE], 2017b). The DTC introduction appears to have created both opportunities and tension in new expectations of teachers and their relative capabilities (Bell et al., 2009; Crow et al., 2019). This research project investigated teachers' adoption of DTC and examined how DTC can be effectively integrated, the main affordances for implementation and what teachers' personal capabilities enabled them to do.

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A qualitative methodology was adopted in this study. This approach allowed for insights into decision-making and motivation within rich lived experiences and contexts. Participatory Action Research (PAR) was selected as the most appropriate research methodological approach, as it allowed teachers to be active participants and was most relevant in obtaining authentic in-situ data (Mertler, 2016). DTC introduced new concepts to teachers and schools, and PAR allowed participants to contribute irrespective of their current knowledge or experience. The research anticipated problems in adopting DTC, as studies, such as those by Bell et al. (2009), identified that educators found aspects of DTC hard to fit into their busy curriculum and had a lack of understanding of how to implement DTC elements, such as computational thinking. Participants articulated uncertainty around implementing DTC, and in the next section, the literature that informs this research is considered.

Within this research the researcher worked with teachers as co-researchers, collaborating together to ascertain the desired outcome for all involved, as the researcher wanted to obtain the most authentic point and be actively involved in upskilling participants and themselves. Working alongside participants included the researcher providing PLD interventions selected by participants and therefore sharing their knowledge of DTC. PAR supported a collective inquiry where the participants and researcher were able to work together to achieve their self-identified outcomes and improve both participants' and the researcher's practice. The researcher's view whilst completing the research lay within a belief that digital technology (DT) is valuable to educational outcomes, that DT should be utilised to benefit the next generation, enhancing their learning, abilities and subsequent employment opportunities. Assisting teachers in their adoption of this new curriculum and anticipating that schools and policymakers might take note of these findings is the main rationale for the research.

NZC primary school curriculum digital technology areas

DTC (MoE, 2017) consists of two new areas within the NZ primary school curriculum (years 0–8): computational thinking (CT) for digital technologies and designing and developing digital outcomes (DDDO). DTC aims to develop students to be creative, critical, and reflective producers and inventors of digital concepts (Te Kete Ipurangi [TKI], 2018a). In these curriculum areas, students learn that humans are responsible for technological advancement in computers and ensure NZ's unique culture is considered.

Within CT, coding and unplugged activities or "non-computerised" activities (activities that do not use a digital device) (TKI, n.d.-a, para. 3) are focused on for the younger students. For example, until Year 5 (9-year-olds), teachers are not expected to use a device for CT, instead, the focus is on "non-computerised algorithmic thinking … and simple debugging" (TKI, 2018b, para. 8). Several authors identify the benefits of teaching CT through unplugged activities (e.g., Bell & Vahrenhold, 2018; Duncan, et al., 2018; Sands, et al., 2018). In NZ, Bell et al. (2009) identified that CT can be difficult to teach, as many administrators lack understanding and find it difficult to apply effectively within the curriculum areas. Other American research has also identified benefits to teaching CT through unplugged activities at all ages and recognise unplugged activities as a valuable way to introduce CT skills to learners and teachers (Curzon et al., 2014). After Year 5, students begin to take their skills and develop these on a computer in programs suitable to their age and stage of knowledge.

The second area of DTC, designing and developing digital outcomes (DDDO) teaches "the cycle of input and output and processing, and captures the essence of what digital devices do for us" (Mindlab, 2019, 2:30). DDDO wants students to work within authentic contexts, taking into account end-users (TKI, 2018c). DDDO encompasses "understanding digital applications and systems" where students "develop, manipulate, store, retrieve, and share digital content in order to meet technological challenges" (TKI, 2018c, para. 20). Through DDDO, students create digital outcomes that are befitting to a need or problem in society (MoE, 2017a). DDDO is expected to be implemented from level two of the curriculum (approximately 7-years-olds). Often teachers are already implementing some aspects of

DDDO through the use of computer applications with students, and typically elements of DDDO will be found in CT.

Funding and research

Do teachers have the required knowledge and skills to implement DTC? In 2018, NZ's Education Minister announced that $38 million was allocated to aid teachers with DTC implementation (Hipkins, 2018). Funding provided access to initiatives such as "Digital passport" (Mindlab, 2019), which steps teachers through DTC content. Alternatively, schools can apply for a specific PLD (Professional Learning Development) facilitator to visit the school via application. Schools justify their needs based on levels of understanding and implementation of DT (not DTC knowledge) (MoE, n.d.).

Although PLD for DTC is claimed to be in place, a recent NZ paper outlines concerns over teachers' DTC readiness and content knowledge in primary schools (Crow et al., 2019). Additionally, the Education Review Office (ERO) released a report which stated:

> Only seven percent of all schools reported they had quite a good understanding, and enough knowledge and skills to start to implement the DT curriculum content. The majority (88 percent) felt somewhat prepared … There is clearly development work to be done in this area. (ERO, 2019, p. 16)

DTC encompasses new areas that have limited primary school-specific research undertaken regarding them; therefore teachers will likely be unfamiliar with DTC requirements. Additionally, PLD appears to focus largely on general DT implementation rather than DTC and concerns over teachers' readiness (e.g., Crow et al., 2019) add to the concern over whether teachers have the required knowledge and skills to implement DTC. The need for DTC is considered in the following section.

Digital technology use in classrooms

Several aspects affect DT use within primary classrooms. This section aims to identify DT integration and how this differs to the DTC; how digital tools are embedded in and changing our NZ schools; and teaching pedagogy and affordances (including opportunities and constraints) in relation to DT and DTC.

There are different interpretations and terminology and an array of research on DT and its integration from around the world (Hamilton, 2007; Hunter, 2015; Reigeluth & Joseph, 2002). DT integration can often be viewed as the use of DT in a classroom. However, the idea of DT integration can be far more complex (e.g., Hamilton, 2007; Hunter, 2015; Reigeluth & Joseph, 2002). Several definitions of DT integration also articulate multifarious elements that should be considered, such as Hunter's (2015) definition: DT integration is "not about the tools being used, but how teaching practice, when it is mindful of pedagogy and rich subject matter, can be enhanced and re-imagined when DT is used to engage students in learning" (p. 3). Hamilton (2007) maintains that using a computer to teach programming, playing games, or using applications for drill practice is not integration. Instead, DT integration is an "instructional choice" (Hamilton, 2007, p. 20) that requires teacher participation, collaboration, intentional planning, and always links into other curriculum areas.

Digital technology implementation versus the digital technology areas in the New Zealand curriculum

It is important to note that digital technology implementation and the Digital Technology Areas in the New Zealand Curriculum are not one and the same thing. Although they are mutually influencing, they are not identical. Digital technology implementation in schools has a broad spectrum, often in a

primary school NZC context this is referred to as e-learning (TKI, n.d.-b) or digital fluency, that is digital tools supporting the mandatory learning areas (MoE, 2007). Additionally, DT implementation could be considered as any digital technology tool being used in classrooms, for any purpose, and might include digital televisions, computers, iPads, smartboards etc.

However, within the NZ primary school DTC, there are specific digital skills identified, and therefore it does not encompass all digital tools and capabilities. Additionally, aspects of the DTC can be taught unplugged and without the use of devices. DTC is specific and precise and relates to areas that build a skill set related to computational thinking and developing digital outcomes rather than the general use of any digital device.

> E-learning is defined as learning and teaching that is facilitated by or supported through the appropriate use of information and communication technologies (ICTs) … The new curriculum content is about teaching learners how digital technologies work then having them use that knowledge to design digital solutions that make a positive difference in our world. (TKI, n.d.-b, para. 4).

Although DTC and DT integration are not the same, they are heavily entwined, and therefore often the considerations for DT integration can also be acknowledged in relation to DTC implementation. Aspects that affect DT and DTC integration are explored further in the following section.

How digital technology is embedded in and changing schools

Several authors consider DT a hindrance (e.g., Meates, 2021; Oppenheimer, 2003), questioning the measurable impact DT has on education, whilst others believe DT can revolutionise education reform (e.g. Prensky, 2001; Rosen, 2010). Nevertheless, DT appears to have a steadfast place in the 21st-century classroom and beyond. Prior to DTC, DT was not a mandatory part of NZ's 2007 primary curriculum subject areas. Several reports have accentuated the evolving importance of students gaining a deeper understanding of digital technologies (a fundamental aspect of DTC), that there is a need for an overhaul in education, and that DT could play a key role in this (e.g., Gander et al., 2013; Prensky, 2001; Reigeluth, & Joseph, 2002) and suggest teachers' pedagogy is a critical aspect.

Pedagogy

An environment that enhances DT skills often needs to foster a complementary pedagogy. Research by Safar and AlKhezzi (2013) attests that DT content is equally as important to the DT medium. The Organisation for Economic Co-operation and Development (OECD) suggests that "technology can amplify great teaching but great technology cannot replace poor teaching" (2015, p. 4). As DT evolves, so too does its associated pedagogy. Several authors and studies recommend the most effective pedagogy for DT integration is social constructivism, which puts the student at the centre of their learning and they construct their own learning from their experiences (e.g., Ertmer et al., 2012; Safar & AlKhezzi, 2013). Within social constructivism, collaborative learning occurs when two or more students are engaged in an activity, interacting with each other and learning together (Dillenbourg, 1999). This perspective of learning repositions learning more as participation in a social practice than as an acquisition process (e.g., Sfard, 1998). While the pedagogical approach can affect DTC implementation, other factors, such as affordances, can also influence implementation.

Affordances

Within classrooms, DT has a range of affordances. Affordance was a term coined by Gibson (1977) to describe the complementarity relationship between the environment and the "user", which relates to

perceivable benefits and restrictions relative to the environment and affects what teachers can do. There are several affordances that affect the implementation of DT, including using multi-representations simultaneously, visual and aural elements, the dynamic nature of the interaction and the haptic affordance (Calder, 2016). These provide opportunities for learning through DT. Although the advantages of DT in education are complex, several specific benefits can be noted. A large K-12 American policy report, released to inform leaders, policymakers and the general public, conducted across 20 years, suggested: "Educational [digital] technology has demonstrated a significant positive effect on achievement" (Noeth & Volkov, 2004, p. 4). Other affordances include students being drivers of their own learning, having greater ownership, collaboration and autonomy of learning and subsequently enhancing motivation and the disparity between learners being reduced (Ahmad et al., 2008; Delialioglu, 2012; Hadiyanto, 2019; Preston et al., 2015).

Although DT is widely accepted in today's NZ classrooms, several factors need to be addressed before DT integration is a possibility. When the environment and hardware are in place, DT use for students still tends to be comparatively low because teachers tend to focus on using it for administrative tasks and find barriers hard to overcome (Kopcha, 2012; Vongkulluksn et al., 2018). Two types of barriers affect teachers: external factors or "first-order barriers" (Ertmer, 1999, p. 50), those items out of the teachers' control, such as the stability of the internet connection; and internal factors or "second-order barriers" (Ertmer, 1999, p. 51), such as the teachers' beliefs or pedagogy (Castek, 2012). Teachers are more likely to include DT in their classrooms if they believe DT is valued by their school, and if they can personally see the benefits (Vongkulluksn et al., 2018). Teachers' technological "value beliefs" (Ottenbreit-Leftwich et al., 2010, p. 1322) are fundamental in their inclusion of DT and how effective they think it will be in assisting with curriculum learning areas.

Several aspects of DTC and DT have been identified above. Although complex, there is little doubt that DT is an important aspect of today's world; however, whether its use is reflected in students' grades and outcomes is still debated. As the literature shows, there is limited NZ-specific research information regarding both DTC areas and how these are implemented. This research moves to fill part of this void and assist teachers by creating current research into teachers' implementation of DTC.

Methodology and methods

This research adopted the qualitative approach of a PAR methodology. Action Research (AR) is a systematic and reflective inquiry process, where the researcher collaborates with subjects in a democratic and holistic manner to address a recognised issue or problem (e.g., Mertler, 2016). Due to AR's democratic processes, it enables participants to become actively involved and reflective, often helping the researcher and participants to solve problems that directly affect them (Mills & Butroyd, 2014). As curriculum change might not be maintained in schools without the support of teachers, it can be beneficial to include the teachers as co-researchers to determine what teachers believe is valuable support (Schleicher, 2018). PAR was appropriate for this research, as participants were able to make decisions about the direction of the research and what was important to focus on, which potentially enabled the research to be beneficial to both researcher and participants. Because the research was conducted in the participants' real-world setting, with the researcher and participants working together to find suitable outcomes, the research could facilitate immediate change (Reason & Bradbury, 2001). PAR "is an ongoing organizational learning process, a research approach that emphasizes co-learning, participation, and organizational transformation" (Morales, 2006, p.159).

The main question this study aimed to answer was: How are NZ's provincial city primary teachers implementing the new technology curriculum (DTC) into their classroom practice? To answer this, two questions were considered: What DT affordances will primary school teachers find during their DTC journey of adoption? And how does a professional learning development intervention help facilitate/enable teachers' implementation of DTC? Figures 1 and 2 show this research AR cycle and its

instruments. Each instrument is unpacked in greater detail and further explanation in the following section. AR allowed flexibility in the appropriate timing of each session (Cohen et al., 2007).

Figure 1. Action research phase one.

Figure 2. Action research phase two.

Study's instruments

Initial pre-research questionnaires and final post-research questionnaires were sent out by Google Drive forms and completed by participants. Both questionnaires aimed to enable participants to respond personally, without others' input. Questionnaires aimed to gain an insight into the initial understanding and ideas of DTC (pre-research) and later any change teachers had made throughout the research, both professionally and personally (post-research). An important concept in selecting questionnaires was that they enabled anonymity and respondents might be more honest, which therefore provides heightened reliability of the data collected (Curtis et al., 2014; Morrel-Samuels, 2002).

Focus-group sessions aimed to explore the teachers' current beliefs and perspectives of DTC. Focus groups aided the discussion of ideas and the ability to add to and extend each other's thinking (Ivey, 2011). The new nature of the DTC dictated that there needed to be a collaboration between teachers to unpack and review DTC. It was feasible that some participants might have limited (or no) knowledge or understanding of DTC and therefore would need to participate in a focus group to draw out any existing understanding. Consideration was given to areas where focus group limitations could occur.

Teachers set goals after the PLD session and from these created and taught a DTC lesson to their class. Class observations took place during these lessons to observe teachers and their classes undertaking DTC tasks. Teachers' goals and reflections were used as evidence in the study and considered integral concepts in the research, as shown in the AR spirals above. Individual goals were set by teachers which acted as the planning element of PAR.

The choice of research design and data collection methods should be relative to a researcher's paradigm (Efron & Ravid, 2014), and based on *best fit* with the research aim (Ryan et al., 2014). PAR methodology enabled the collection of evidence, such as opinions, beliefs, informal knowledge and other anecdotal information. The PAR cycle enabled this research to review evidence in a systematic, continuous and reflective cycle. Mertler's (2016) notion that the research is there to benefit the researcher and their participants was maintained; therefore, if new and beneficial information came to light, it might have been justified to alter the direction of any part of the research. In this research, data

analysis began as soon as the data was collected. The data analysis utilised the phases of thematic analysis as identified by Braun and Clarke (2006) in Table 1.

The participants were teachers from one provincial city primary school. Teachers included a range of year levels (junior age 5 to 7, middle age 8 to 9 and senior age 10 to 11), and a range of capabilities, experience and confidence in teaching DT (low, moderate and high). This was a purposive sampling method, enabling the research to ascertain a broad perspective as possible from a minimal sample. Participants varied in age and personal DT use, and pseudonyms were used for all names. The research project gained approval from the University of Waikato ethics committee. This approval included having all participants being invited to participate, giving informed consent, including participant assent for the student participants, confidentiality (e.g., transcriber confidentiality agreements), anonymity (e.g., use of pseudonyms), mitigation of the potential influence of power differentials, and participants' right to withdraw. Research validity was enhanced through the design of the project matching the purpose of the research questions, using a range of methods to generate the data, the design of the analysis plan, the range of contexts and participants (given the place of context in design-based research), the frequency of design iterations, the collaborative teacher/researcher research team, and ongoing peer-review of the formative findings through the research team and their colleagues.

Thematic analysis

All data elements obtained were analysed for thematic codes as identified by Braun and Clarke (2006). Reading and re-reading the qualitative data in the transcripts was the first step in thematic analysis (Braun & Clarke, 2006). Appropriate codes were extracted, representing both explicit ideas and underlying (inferred) ideas. Table 2 provides an example of how the transcript codes were identified and colour-coded. When themes fell into two coding categories "*also*" is used. It was an iterative process and once the initial codes were identified and organised according to frequency, they were put into a mind map to organise, obtain and show interlinking features. Once interlinking features were identified, several sub-themes and then three main themes emerged (see Tables 2 and 3). Braun & Clarke's (2006) six-step thematic analysis, in relation to this research, can be seen in Table 1.

Table 1. ***Braun & Clarke's (2006) Six-Step Thematic Analysis with Related Information to This Study***

Phase	**Researcher's process**
Familiarise oneself with data	Transcribing interviews and reviewing data collected from research instruments. Re-reading, noting down, and thinking of initial codes.
Generating initial codes	Coding aspects from data collection methods, including transcripts (See Table 2).
Searching for themes	Collating codes into potential themes.
Reviewing themes	Generating a thematic map.
Defining and naming themes	Refining each theme, including generating a clear title (sub and main themes).
Producing report	Discussion of analysis. Selecting appropriate extracts relating to research questions.

Table 2. ***Transcript Example of Coding Analysis***

Participant	Transcript	Codes
Laura	I used that with mine too—that's what we use as our reading rotation. Cos I find I can set them up and they can kind of go at their own pace. At their own pace with it once they've had a bit of a go. But then I find that it does have aspects of like they can tell their character what to do using the blocks in that kind of thing. Then I know from then on you can sort of like—scratch does have things that you can go and create. But that's where I'm a bit like woah.	Integration Creating (also) coding integration(also) Coding Confidence (Also personal DT Knowledge)

The research identified several main themes and sub-themes discussed in the following section.

Results and discussion

The themes that transpired from the thematic analysis of the data are shown in Tables 3 and 4. Several of the themes that emerged were not surprising considering the existing research on DT implementation. However, several main themes, such as teacher knowledge and teacher understanding, developed ideas that appear to have minimal existing research in relation to DTC

Table 3. ***Phase One Sub and Main Themes***

Sub themes	Main themes
Integration	Integration
Time	
Personal knowledge of DT	Teacher knowledge: Initial understanding
DTC curriculum content (knowledge)	
Pedagogy (knowledge and understanding)	
Confidence	Confidence

Table 4. ***Phase Two Themes and Sub-Themes***

Sub-theme	**Main emergent themes**
Professional development	Teacher knowledge: Professional learning development
School support	
21st century skills	Integration
Integration	
Confidence	Confidence

Key findings and discussion

There is no single answer to the posed research questions. Although several key themes emerged through the analysis, at times they were mutually influenced by each other. Often there was also evidence of the themes simultaneously contributing to the findings of this research.

This section discusses three main themes that emerged from this research: teacher initial understanding and professional learning development, curriculum integration, and confidence. Within the themes discussed below, there is an emphasis on the new findings and contributions to the field.

Teacher knowledge

Teacher knowledge was a prevalent theme from phases one and two. In phase one teachers discussed their knowledge in relation to their initial understanding of DTC. Phase two, however, saw a shift in teachers' discussions surrounding teachers' knowledge moving to their requirement for ongoing development of knowledge and future PLD.

Phase one appeared to indicate misconceptions and an initial lack of clarity around DTC. It was not surprising that this study found that teachers lacked confidence in the use of both DT and DTC implementation in their classrooms; however, this appeared to be heavily entwined with the transparency of DTC content.

> Cacey: It's the what, what is it [DTC]? And what do we do? And how do we do everything? … And coding—what it encompasses, what it [DTC] all really is, what it [DTC] all really is in layman's terms.
>
> Laura: This is where I get confused about what it [DTC] does and what it [DTC] doesn't … The whole thing I find is I don't know how much I'm supposed to be doing.

DTC progress outcomes seemed unclear, including what they encompassed, and teachers felt they would need a high level of DT skill to teach DTC:

> Mia: Where do I start? It's [DTC] something that you have to have some small understanding of before you just say "hey this is what we're doing". Sometimes if it [DTC] goes wrong, at least you've got something to learn from it, but this is the kind of thing that you need to at least have a little bit of knowledge on.

> Laura: It's [DTC] hard because at my last school we had a tech teacher and in our CRT they would go to Steve and they would make robots out of Lego and all this cool stuff. But you have no idea how to do that.

Additionally, teachers were unaware that unplugged activities are the expectation of the CT progress outcomes up to Year 4 and part of the expectation at senior levels five and six (up to and including 9-year-olds).

In phase two, teachers expressed relief that DTC could be less complex than imagined and in relation to how easily the unplugged activities could be used:

> Cacey: I never knew there were non-computer activities … I didn't even know I was doing digital technology.

> Mia: It was really good to see how simple it can be implemented … In some way, we were each already incorporating aspects of the [DTC] curriculum into our practice.

Phase two identified concerns around available and ongoing PLD and access. There appeared to be a large disconnect between PLD available to teachers and what teachers were utilising or knew was available. These findings support the Principal Association's comments that there is not enough DTC PLD in place for all schools (Cormick, 2019; ERO, 2019). At no point in this research project were any available government PLD initiatives mentioned. Here, Mia (who was tasked with the dual responsibility of the school's PLD around technology) suggests that although they have been proactive in trying to acquire available PLD, they are unsure of the content or quantity available:

> Are we behind the eight ball? These schools are doing things. But then when you go digging, obviously the intermediates are doing stuff. We've approached other primary schools and they're like "oh we're not doing that". We approached two schools in Auckland, and they were doing this, this and this. It seems you've either gone really far ahead with it or you're not doing enough. It's hard to gauge where you should be at. And what it looks like, I guess it's going to look different for everybody. What are we aiming for? I mean what is an ideal?

Hipkins (2018) suggests PLD is available to teachers, but it appears this is not being utilised. This could be due to several aspects, such as a lack of clarity on where and how to obtain PLD, unsuccessful funding applications or that available resources are not seen as useful. It might also be considered that if these resources were utilised and more readily available, they could assist in aiding clarity around DTC content and curriculum integration and assist with teachers' confidence, which are the other two major findings of this study, discussed below.

Curriculum integration as an approach

The NZC (TKI, 2018a) suggests that teachers use a "cross-curricular" (para. 7) approach to teaching technology as part of a theme or topic. Phase one of the research showed uncertainty in relation to where DTC could be integrated with other parts of the curriculum:

> Laura: It's another thing in the crowded curriculum. All I've really got is that I set them up on a coding program and they do that as part of their reading rotation … Is it a standalone curriculum and we teach it like we teach reading writing maths or do we …? How do you do it as part of reading, writing or math? … But then how do you integrate that? Into a guided maths group? Or do you do something else?

> Mia: That's what I find hard. Or do I teach it separately?

The concept of integration can also be linked with unplugged activities. During phase two of the research, many of the teachers utilised unplugged activities when implementing DTC. The unplugged activities formed a large part of the teachers' goals and reflections and were mentioned several times as beneficial. Towards the end of the study, comments such as these were commonplace:

> Casey: The unplugged component of the DT curriculum will be something that I think will be easy to integrate with many other activities we do with junior children; particularly with oral language activities.
>
> Mia: I've tailored my lessons around more unplugged lessons this year with the occasional use of bots to consolidate those learnings. By tackling the teaching and learning this way, I think it has been more beneficial for my own learnings and also for student understanding, particularly around computational thinking and the steps involved and how this can affect the overall outcome.
>
> Laura: It has been good to find out that the biggest focus for children in primary is unplugged activities.

The use of unplugged tasks seemed to support the simpler integration of DTC into other curriculum areas, encompassing activities that many teachers were already undertaking in their classes.

Teacher confidence

Confidence was another finding of this study. Many of the above comments can be identified as having inferred interlinking features to confidence. Initially, teachers appeared to lack confidence in DTC:

> Mia: I've tried to see it [DTC], but I don't even know if I'm right about it [DTC].
>
> Cacey: It's [DTC] over my head.
>
> Laura: I have no idea how to do that stuff!

However, opportunities to implement DTC and associated PLD appeared to increase teachers' confidence. Their quotes also show a shift in the level of articulation of ideas likely associated with their increase in confidence. Given the research available regarding DT and confidence, such as Greener and Wakefield (2015), who reported that although teachers were excited about using DT, confidence and beliefs around justifying using DT in classrooms were barriers teachers needed to overcome; the relationship between confidence and DTC was no surprise. However, by the second phase of the research, the following comments were commonplace:

> Mia: Meeting about this research, as well as working alongside Cacey and Laura really helped with understanding and putting into practice both POs.
>
> Laura: I feel more confident implementing the digital technologies curriculum after these lessons. It's less daunting than I originally thought.
>
> Cacey: It's [DTC] not as hard as I imagined before.

The pre- and post-questionnaires also asked teachers to identify where they rated themselves in terms of their personal DT expertise both individually and within classroom implementation. The final questionnaire showed there had been shifts in both these areas for most of the teachers, towards a higher level of rating.

The findings in this section contribute to the field of implementing DTC into classrooms. As discussed, teachers' initial knowledge and understanding and ongoing PLD was an important factor for teachers. Additionally, the integration and unplugged activities were particularly acknowledged by

teachers who felt this made DTC easier to integrate and increased their confidence. The following section clarifies the unique perspective that this study holds.

Study's unique perspective

This study holds a unique perspective due to its provincial city primary school context and the PAR approach that was utilised. The above findings differ from other research and findings due to teachers being unfamiliar with DTC as it became mandatory the year after this study was undertaken (2020). There has been little research undertaken specifically in relation to primary school level DTC in a NZ context. Most other research and findings similar to this study are driven from a DT or CT perspective, rather than a primary school DTC perspective. Additionally, other similar curriculums around the world are also reasonably new and therefore also have limited associated research.

Conclusion

There is no doubt that DT is creating changes in our society and our schools. In 2020, DTC was added to the technology subject area. DTC aims to assist students in becoming creators of DT, rather than passive users. There are pedagogies and multiple barriers as well as benefits associated with DT implementation, with much of the DT literature focusing on DT aspects and not DTC specifically.

This study adds to the literature on DTC implementation at a primary school level, with several evident themes. Firstly, within teachers' knowledge, there are misconceptions and a lack of clarity around DTC. This main theme appeared to be mutually influencing with the other main themes, confidence and integration, and during the researcher's second phase teachers identified what appeared to be a disconnect between available PLD and teachers' access. Another main aspect of this finding was that teachers did not know much of DTC could be taught unplugged.

It is not surprising that there is limited research regarding DTC implementation. However, considering this research and its findings, the following areas warrant further research to gain a deeper understanding of DTC implementation. Further research into teachers' DTC misconceptions, access and availability of government PLD, and DTC resources and why these are not being accessed would be beneficial. Additionally, further research around the current barriers and benefits to implementing DTC specifically at NZ primary school levels might be informative.

This project's findings emphasise the need for greater research and thought by schools into DTC implementation, particularly to aid teachers in overcoming misconceptions around DTC content and gaining confidence and accessibility to PLD. An aspiration for these findings is that the adoption of DT and DTC will be taken seriously in schools, so the students of today are not disadvantaged as the workers of tomorrow, and the digital divide is not able to prevail. Instead, students will be encouraged to foster meaningful DT and DTC skills and become well-informed and equipped to deal with the social and professional needs they will face as digital citizens.

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